Some characteristics of the combined PHENIX upgrade inner tracker: TPC + Barrel Silicon Vertex Detector (VXD)

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Outlook:

✓Design parameters.

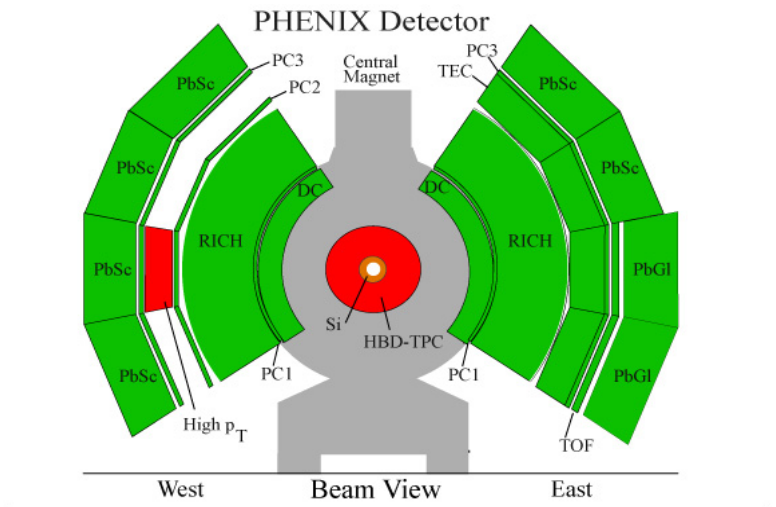
✓Single-track simulation model.

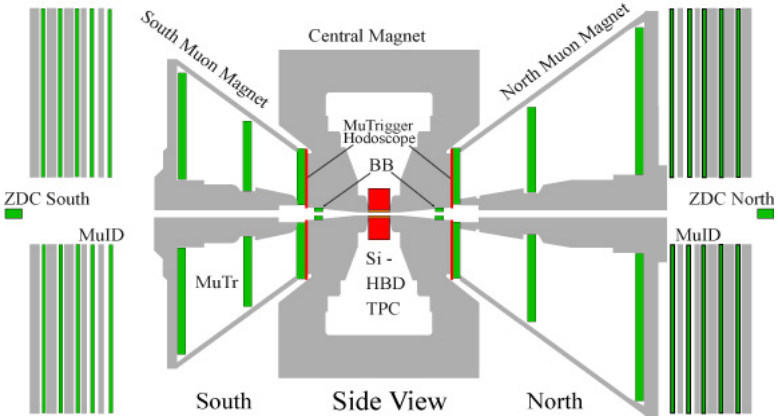
✓Momentum resolution.

✓Impact parameter resolution.

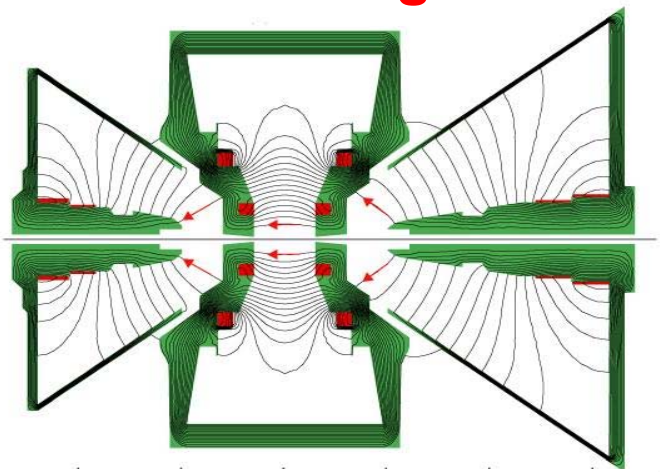
✓Brief summary.

PHENIX upgrade with a Inner Tracker

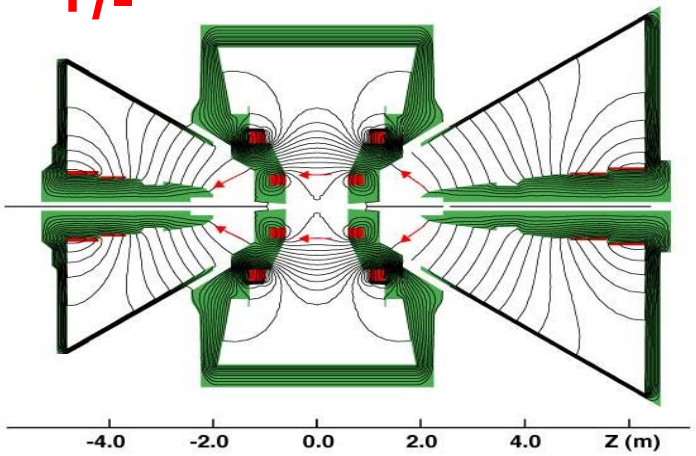




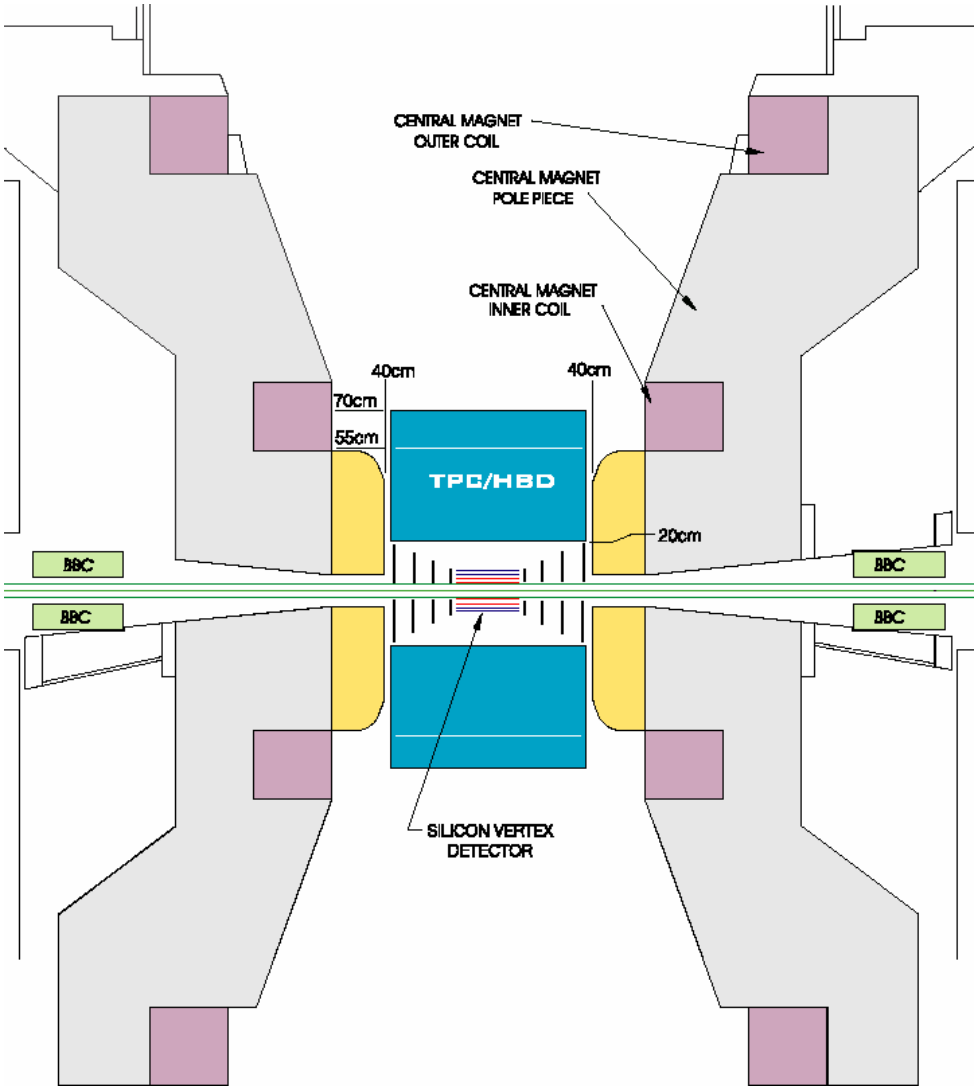
+/+ field configuration



+/-



PHENIX Inner Tracker Design Parameters



TPC:

- 35 tracking layers at the radii from 20 to 55 cm.
- $\sigma_{r\varphi} \approx 250$ μm, $\sigma_z \approx 300$ μm.

Barrel VXD:

- 2 pixel and 2 μ-strip layers at the radii from 2.5 to 10 cm.
- $\sigma_{r\varphi} \approx$ 14-23 μm
- $\sigma_z \approx$ 120-300 μm

❖ **TPC tracking coverage:**

$\Delta\varphi = 2\pi$

$-0.7\ (-1) < \eta < +0.7\ (+1)$

❖ **VXD tracking coverage:**

$\Delta\varphi = 320^{O}$ (Barrel) to 2π (Endcap)

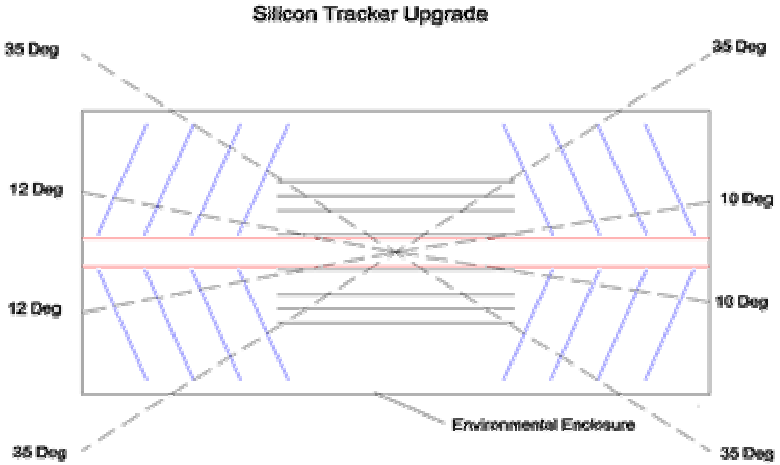
$-2.7\ (-3.4) < \eta < +2.7\ (+3.4)$

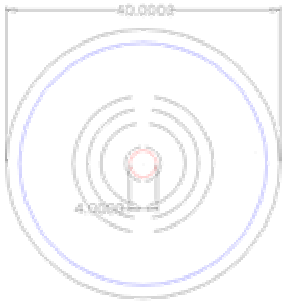
❖ **Central Arm coverage:**

$\Delta\varphi = \pi/2 + \pi/2;$

$-0.35 < \eta < +0.35$

Silicon Vertex Detector





Conceptual Mechanical Specifications

Central Barrel

layer radius	2.5,6,8,10 cm
layer length	30 cm
pixel size	50 μm x 425 μm
strips	80 μm x 1mm (3cm)
pixels(1st layer)	~1.9M
strips(2nd,3rd,4th layer)	~165k
azimuthal coverage	320 deg

End Caps (each)

inner radius	2.5 cm
outer radius	18 cm
disk z pos.(at r_{in}= 2.5cm)	20,26,32,38 cm
pixel size	50 μm x 4 mm
total pixels	~2.0M
azimuthal coverage	360 deg

Simulation model

- **Geometry**: Parallel flat tracking layers.

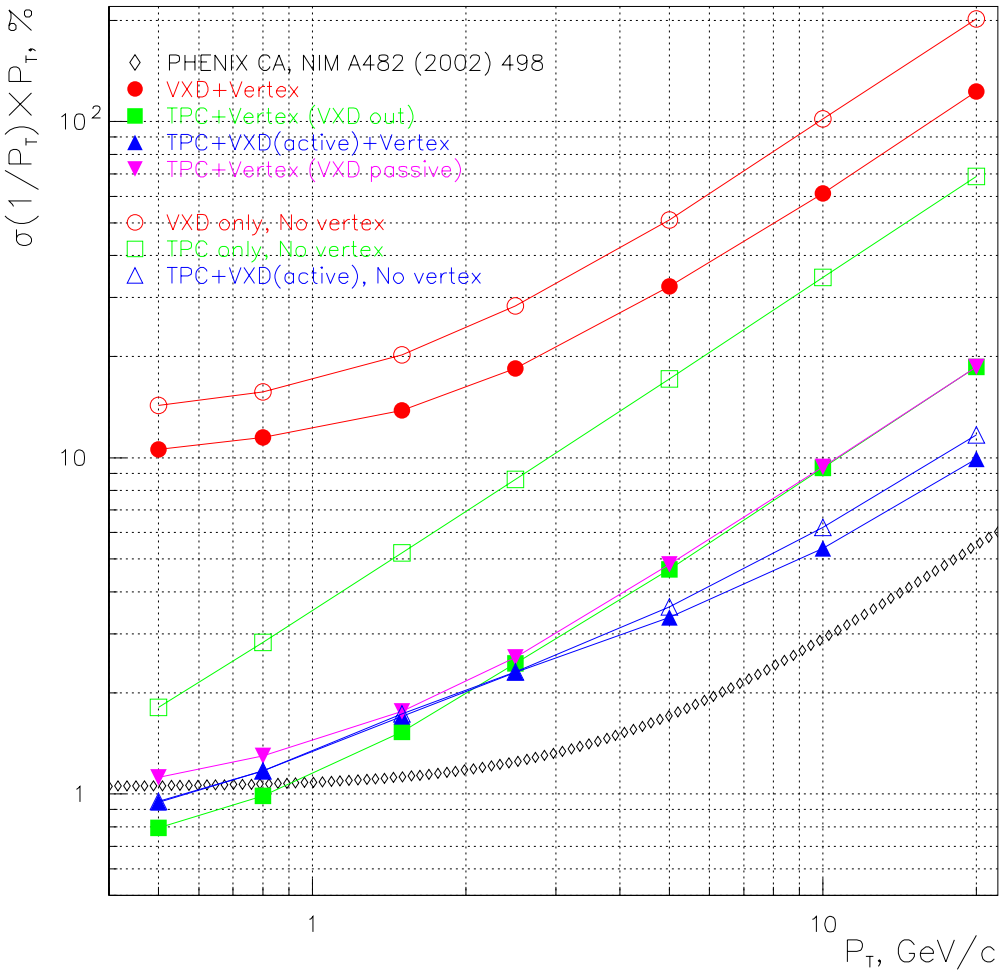
- **Particle trajectories** in the *uniform magnetic field* **generated**, taking into account *small angle multiple scattering* (β=1) in the *detector material*, *beam pipe*, *air, etc*. Ionization and radiation energy losses ignored.

- The positions of the track crossing points in each layer randomly Gaussian smeared with the respective design *position resolutions.*

- At this stage, the **vertex transverse position** (σ_{xy}) , if used, has been assumed at *20 μm* with the VXD used, and *50 μm* for the TPC only.

- For the **helical trajectory reconstruction**, the *full initial covariance matrix* has been used, taking into account *cross-correlations* of the track crossing points in the tracking layers *due to multiple scattering*.

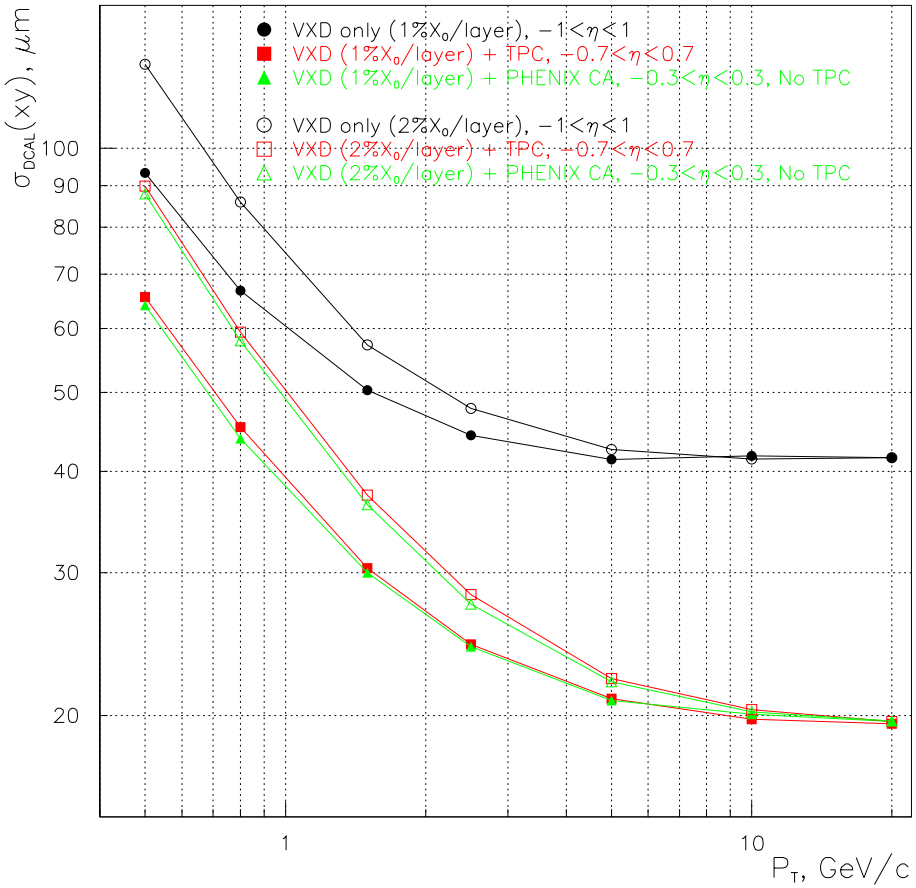
Momentum resolution, B = 9 kGs

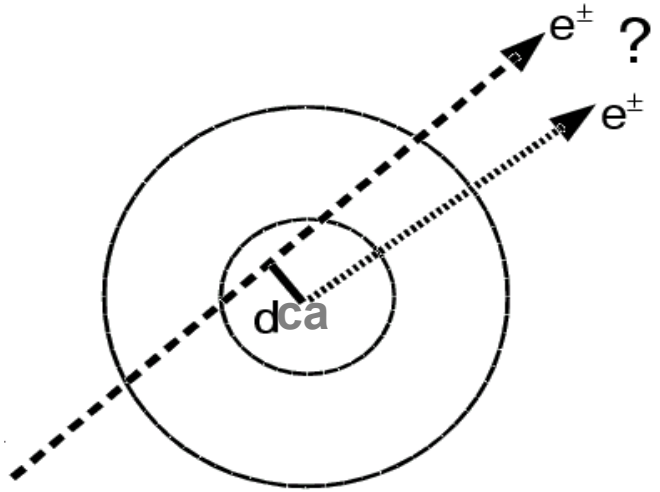


Comparison of the **momentum resolutions**:

- *PHENIX Central Arm*
- *VXD standalone*
- *TPC standalone*
- *VXD + TPC*

Impact parameter resolution, B = 9 kGs





Signal: ***Heavy Flavor*** $\rightarrow$ ***e±X***

DCA > 0

Background: ***Prompt e±***

DCA = 0

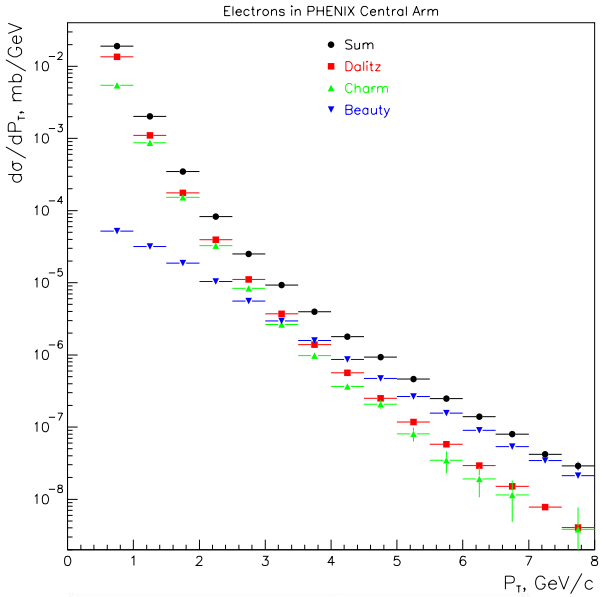
❖ *Known* **"zero field":**

σ_{DCA} would be the same as for $B \neq 0$.

❖ *Unknown* **"zero field"** *(B ~150 Gs)* **– *using straight line fit in the VXD only*:**

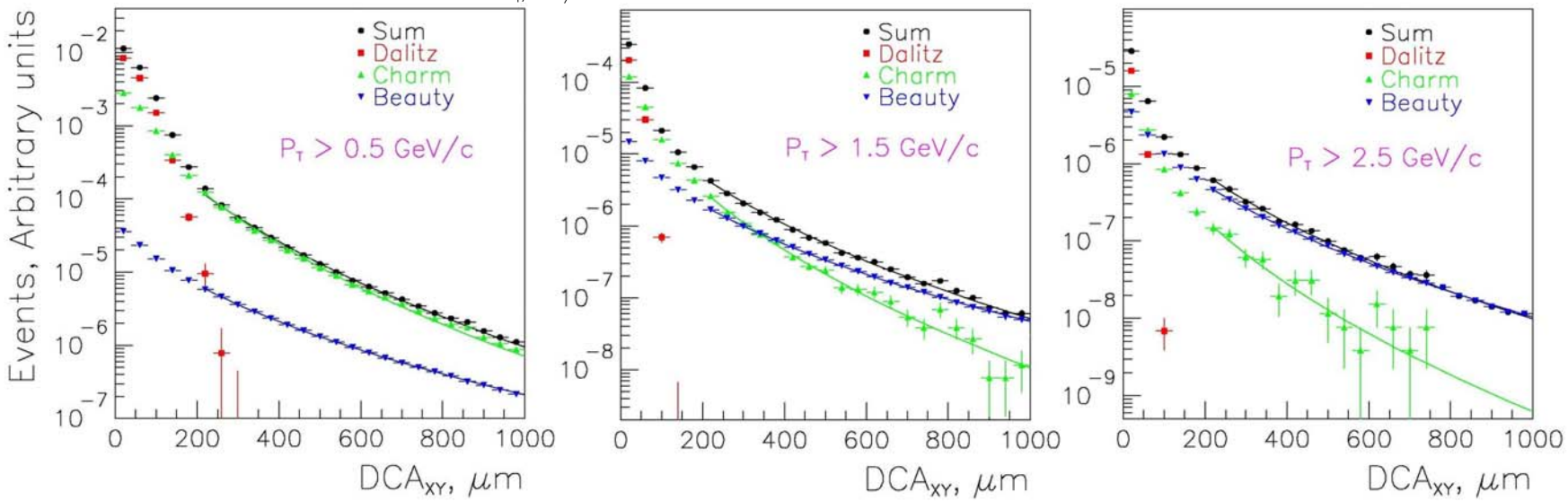
At $P_T > 0.2\text{-}0.3$ *GeV/c* expect σ_{DCA} about the same as for the *known momentum.*

Example of using DCA distributions



pp at $\sqrt{S} = 200$ *GeV:*

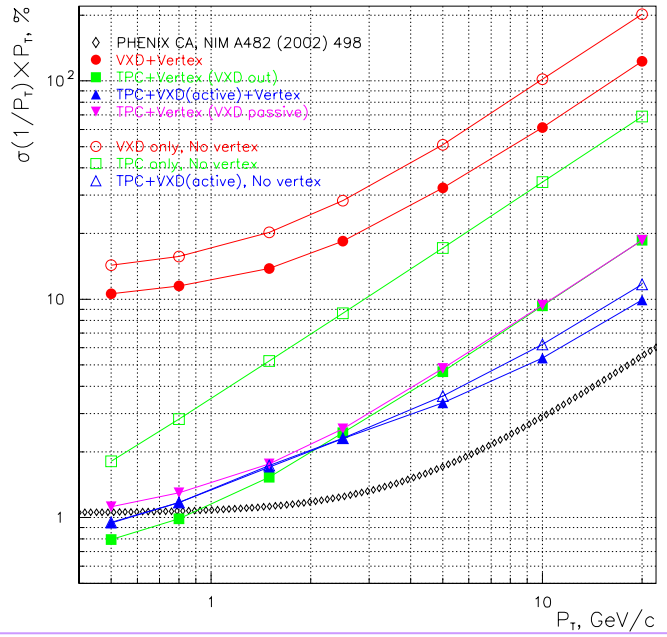
- Heavy flavor: *PYTHIA*
- Dalitz: *from PHENIX measured* π^0

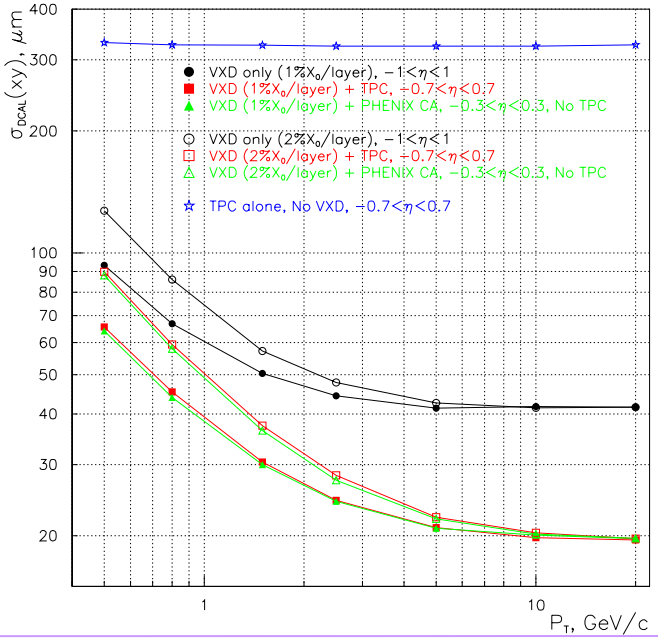


Summary: *Everybody in the team does its job !*

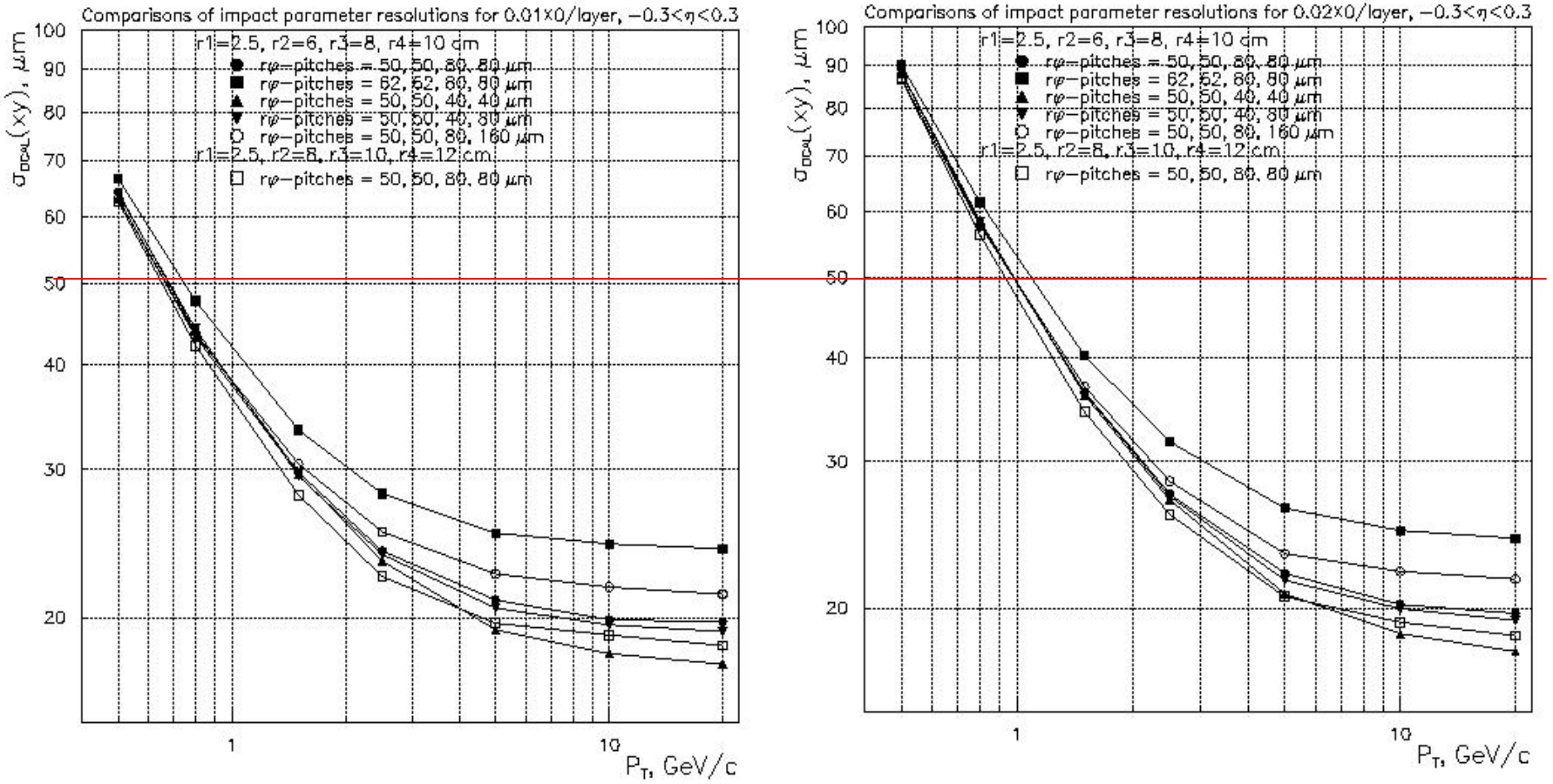
- The shown examples illustrate the *complementarities* of the two parts, *TPC* & *VXD*, of the proposed new PHENIX *Inner Tracker*.

- The *momentum* and *DCA* resolutions, combined with the *electron identification* provided by the *HBD*, seem to be sufficient for treating the Inner Tracker as a capable "standalone" PHENIX sub-detector for doing a substantial physics *(heavy flavor, jets with charged, …)* in the extended acceptance of about $-0.7 < \eta < 0.7$; $\Delta\varphi \approx 2\pi$.





Impact parameter resolution, B = 9 kGs



Simulation result: $\sigma_{DCAL} < 50\ \mu$ at $P_T > 0.65$–1 *GeV/c*